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(54) **Fluidized bed steam generating system including a steam cooled cyclone separator.**

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(56) References cited :
EP-A- 0 216 677
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EP 0 413 612 B1

Description

This invention relates to a fluidized bed steam generating system and, more particularly, to such a system in which a cyclone separator is provided and is cooled by steam generated in the system.

Fluidized bed combustion systems are well known. In these arrangements, air is passed through a bed of particulate material, including a fossil fuel such as coal and an adsorbent for the sulphur released as a result of combustion of the coal, to fluidize the bed and to promote the combustion of the fuel at a relatively low temperature. Water is passed in a heat exchange relationship to the fluidized bed to generate steam. The combustion system includes a separator which separates the entrained particulate solids from the gases from the fluidized bed in the furnace section and recycles them back into the bed. This results in an attractive combination of high combustion efficiency, high sulphur adsorption, low nitrogen oxides emissions and fuel flexibility.

The most typical fluidized bed utilized in the furnace section of these type systems is commonly referred to as a "bubbling" fluidized bed in which the bed of particulate material has a relatively high density and a well-defined, or discrete, upper surface. Other types of fluidized beds utilize a "circulating" fluidized bed. According to this technique, the fluidized bed density may be below that of a typical bubbling fluidized bed, the air velocity is equal to or greater than that of a bubbling bed, and the flue gases passing through the bed entrain a substantial amount of the fine particulate solids to the extent that they are substantially saturated therewith.

Also, circulating fluidized beds are characterized by relatively high solids recycling which makes it insensitive to fuel heat release patterns, thus minimizing temperature variations, and therefore, stabilizing the emissions at a low level. The high solids recycling improves the efficiency of the mechanical device used to separate the gas from the solids for solids recycle, and the resulting increase in sulphur adsorbent and fuel residence times reduces the adsorbent and fuel consumption.

However, several problems exist in connection with these type of fluidized systems. For example, it is often necessary to add expensive cooling surfaces for superheating the steam generated in the boiler. Also, difficulties arise in controlling the temperature range of the steam generated in the system. Further, these types of beds are used in systems, such as steam generators, which include one or more cyclone separators normally provided with a hopper connected to their lower end to collect the solid particles from the separator. The separator and the hopper are usually provided with a monolithic external refractory wall which is abrasion resistant and insulative so that the outer casing runs relatively cool. However, in order to achieve proper insulation, these walls must be relatively thick which adds to the bulk, weight, and cost of the separator and hopper and require controlled, relatively long, start-up and shut down times to prevent cracking of the refractory. Also, the outside metal casing of these designs cannot be further insulated from the outside since to do so could raise its temperature as high as 816°C (1500°F) which is far in excess of the maximum temperature it can tolerate. Still further, conventional separators installed in the above manner require a relatively long time to heat up before going online to eliminate premature cracking of the refractory walls, which is inconvenient and adds to the cost of the process.

Still further systems utilizing a fluidized bed and a cyclone separator require relatively expensive, high temperature, refractory-lined ductwork and expansion joints between the fluidized bed furnace and separator, and between the cyclone and a heat recovery section, which are fairly sophisticated and expensive.

It is therefore an object of the present invention to provide a steam generating system utilizing a fluidized bed boiler which overcomes the aforementioned disadvantages of previous systems.

According to the invention there is provided a fluidized bed steam generating system comprising:

(A) a furnace comprising:
  (1) an enclosure containing solid particulate material including fuel; and
  (2) means for introducing air into the enclosure at a velocity sufficient to fluidize the particulate material and support combustion or gasification of the fuel to produce flue gases which rise in the enclosure and entrain a portion of the particulate material:

(B) a cyclone separator comprising:
  (1) an inner cylinder; and
  (2) an outer housing surrounding the inner cylinder for forming a separating chamber, the outer housing comprising:
    (a) a plurality of parallel tubes; and
    (b) means connecting the tubes to form an air tight structure;

(C) a heat recovery section comprising:
  (1) an enclosure comprising:
    (a) a plurality of parallel tubes; and
    (b) means connecting the tubes to form an air tight structure;
  (2) a plurality of bundles of tubes (82a, 82b, 80a, 80b, 84a, 84b) disposed in the enclosure;

(D) means for passing the flue gasses from the furnace section to the chamber for separating the entrained particulate material from the flue gases by centrifugal forces;

(E) means for passing separated particulate material from the separator back to the furnace section; and

(F) means for passing the separated flue gases to the heat recovery section.

Such a fluidised bed steam generating system is known from document EP-A-0 298 671.

The invention differs therefrom in that the following items are also supplied:

fluid flow circuit means comprising:

(1) a steam drum;

(2) a lower ring header formed in two sections respectively connected to portions of the tubes forming the outer housing of the separator sections respectively connected to the said portions of the tubes forming the outer housing of the separator;

(3) means for connecting the steam drum to a section of the lower ring header and in turn one portion of the tubes for passing steam to one section of the upper ring header to cool the separator; and

(4) means for connecting the tubes forming the outer housing to the tubes of the heat recovery section so that fluid passing through the latter tubes is heated by the separated flue gases.

In a steam generating system according to the invention separate superheating surfaces are not required. Also improved control of the temperature range of the fluid being heated is provided. Further, the exterior surface of the cyclone separator can be maintained relatively stable and cool whilst at the same time heat losses are reduced and the requirement for internal refractory insulation is minimized.

The bulk weight and cost of the cyclone separator can therefore be much less than that of conventional separators. Finally, the need for expensive, high-temperature, refractory-lined ductwork and expansion joints between the furnace and the cyclone separator and between the latter and the heat recovery section are minimized. Therefore relatively quick start-up and load changes are possible.

The invention will now be described by way of example with reference to the following detailed description of thepresently preferred embodiments in accordance with the present invention, in which:

Figure 1 is a schematic representation depicting the system of the present invention; and

Figure 2 is a cross-sectional view through the separator shown in Figure 1.

Referring specifically to Figure 1 of the drawings, the fluidized bed combustion system 10 of the present invention includes a furnace section 12, a cyclone separator 14, and a heat recovery section 16. The furnace section 12 includes an upright enclosure 18 and an air plenum 20 disposed at the lower end portion of the enclosure for receiving air from an external source. An air distributor, or grate, 22 is provided at the interface between the lower end of the enclosure 18 and the air plenum 20 for allowing the pressurized air from the plenum to pass upwardly through the enclosure 18. The tubes forming the upper portion of the rear wall of the enclosure 18 are bent out of the plane of the wall to form an outlet 18a for flue gases and entrained particulate material, as will be described.

One or more inlets 24 are provided through the walls of the enclosure 18 for introducing a particulate material into the enclosure The particulate material can include coal and relatively fine particles of an adsorbent material, such as limestone, for adsorbing the sulphur generated during the combustion of the coal, in a known manner. The air from the plenum 20 fluidizes the particulate material, as will be described. It is understood that a drain pipe registers with an opening in the air distributor 22 and/or walls of the enclosure 18 for discharging spent particulate material from the enclosure.

The walls of the enclosure 18 are formed by a plurality of tubes disposed in a vertically extending spaced, parallel relationship and connected by continuous fins (not shown) extending from diametrically opposed portions of each tube and are welded between adjacent tubes to form a gas tight structure. Since this construction is conventional, the walls will not be described in any further detail.

Flow circuitry is provided to pass water, steam and/or a water-steam mixture (hereinafter termed "fluid") through the tubes to heat the fluid to an extent that it can be used to perform work such as, for example, drive a steam turbine. To this end, headers, which are not shown for the convenience of presentation, are provided at the upper and lower ends of the walls forming the enclosure 18 for introducing fluid to, and receiving fluid from, the tubes forming the respective walls. A natural circulation steam drum 32 is connected by conduits 34 and 36 and other conduits and headers which are not shown, to the walls of the enclosure 18 to establish a fluid flow circuit as will be described. This flow circuit includes a downcomer 38 connecting the upper section of the stream drum 32 to a lower ring header 48 for cooling the cyclone separator 14 and will be described.

The cyclone separator 14 may include an upper roof section 40, a conically-shaped lower hopper section 42 and an intermediate cylindrical section 44. The header 48 is in the form of a ring and is divided into two separate sections 48a and 48b. It is disposed at the lower end of the hopper section 42. An upper ring header 50 is disposed above the roof section 40 and two separate sections 50a and 50b connected by a conduit 74.

Each of the sections 40, 42 and 46 are formed by a group of continuous, spaced, parallel tubes 52 spanning the entire length of the separator 14 and connected at their lower ends to the header 48 and at their upper ends to the header 50. As better shown in Figure 2, the tubes 52 are spaced apart and a continuous fin 54 extends from diametrically opposed portions of each tube and is welded between adjacent

tubes. The structure thus formed is disposed between an inner refractory material 56 and outer insulative material 58. The refractory material 56 can be a relatively thin layer of high conductivity refractory and the insulative material 58 may be of any conventional design.

An inlet 60 is provided to the interior of the cylindrical section 44 and can be formed by bending a portion of the tubes 52 out of the plane of the cylindrical section as shown in more detail in U.S Patent No. 4,746,337 assigned to the assignee of the present invention, the disclosure of which is incorporated by reference.

The hopper section 42 is formed by bending the tubes 52 radially inwardly from the intermediate section 44, and the roof section 40 is formed by bending the tubes 52 radially inwardly at an angle, as shown by the reference numeral 52a, and then upwardly at an angle, as shown by the reference numeral 52b.

An inner pipe, or cylinder 62 is disposed within the cylindrical section 44, is formed from a solid, metallic material, such as stainless steel, and has an upper end portion extending slightly above the roof section 40. The pipe 62 extends immediately within the circular opening defined by the apex formed by the bent tube portions 52a and 52b. An annular chamber 64 is formed between the outer surface of the pipe 62 and the inner surface of the cylindrical section 44, for reasons that will be described.

A discharge pipe 66 extends from the lower end of the hopper section 42 and is connected to a seal pot 68 which, in turn, is connected to the rear wall of the enclosure 18 by a pipe 69. The pipe 69 registers with an opening formed in the rear wall of the enclosure 18 for introducing recycled particulate material from the separator 14 back into the enclosure as will be described.

The ring header sections 48a and 48b, and 50a and 50b are respectively connected to the tubes 52 forming lest side and the right side of the separator 14.

The steam drum 32 is connected, via the downcomer 38, and branch pipes 38a to the section 48a of the lower ring header 48. The fluid from the steam drum 32 is thus conveyed by the downcomer 38 to pipes 38a by gravity and passes upwardly from the latter to the ring header section 48a. Thus steam passes upwardly through the tubes 52 forming approximately the left side of the separator as viewed in Figure 1 and enters the ring header section 50a by natural convection.

The two sections 50 and 50b of the upper ring header 50 are formed by a conduit 74[1]. Therefore steam recovered by the section 50a passes to the section 50b. Therefore the steam from the section 50b passed downwardly through the tubes 52 forming the right side of the separator 14. After passing downwardly through the latter tubes, this steam enters the lower ring header section 48b from which it passes to the branch conduit 38b.

Although not shown in the drawings fro the convenience of presentation, it is understood that the outlet 18a of the furnace section 12 is connected, by a suitable gas channel, enclosure, or the like, to the inlet 60 of the separator 14. The flue gases and entrained particulate material from the enclosure 18 pass into he annular chamber 64 of the separator and the particulate material is disengaged from the flue gases due to the centrifugal forces created in the latter chamber in a conventional manner. The separated flue gases rise in the separator 14 by convection and discharge from the pipe 62. Although not shown in the drawings for the convenience of presentation, it is understood that suitable ducting or the like connects the pipe 62 of the separator 14 to an inlet formed in the upper portion of the heat recovery section as will be described.

The heat recovery section 16 includes an enclosure 70, to walls of which are formed by a plurality of tubes connected in the same manner as described in connection with the walls of the enclosure 18. The upper and ends of the walls forming the heat recovery section are connected to a riser pipe 75 connected to the branch conduit 38b, and includes branch pipes 75a and 75b respectively connected to headers 76 of the heat recovery section 16 for passing the steam through walls of the enclosure 70.

A pair of primary superheaters 80a and 80b, finish superheaters 82a and 82b and economizers 84a and 84b, all of which are formed by a plurality of bundles of beat exchange tubes, are disposed in the enclosure 70 and all are connected to headers 88. It is understood that the headers 88 are connected to the aforementioned fluid flow circuitry including the steam drum 32 and/or to a steam turbine, or both.

The tubes forming the upper end portion of the front wall of the enclosure are bent out of the plane of the wall to form an inlet 70a for receiving the gases from the pipe 62 of the separator 14.

These gases thus pass into the enclosure 70 as shown by the dashed lines in Figure 1. In the enclosure 70 the gases pass in succession through the superheaters 80a, 80b, 82a and 82b and the economizers 84a and 84b. An outlet 70b is formed in the rear wall of the enclosure 70 for discharging the gases as also shown by the dashed lines.

The separated solids from the separator 14 pass from the hopper section 42 of the separator into and through the discharge pipe 66 before passing through the seal pot 68 and the pipe 69 for injection into the enclosure 18.

In operation, particulate fuel material from the inlet 24 is introduced into the enclosure 18 and adsorbent material can also be introduced in a similar manner, as needed. Pressurized air from an external source passes into and through the air plenum 20,

through the air distributor 22 and into enclosure 18 to fluidize the material.

A lightoff burner (not shown), or the like, is provided to ignite the particulate fuel material. When the temperature of the material reaches an acceptably high level, additional fuel from the inlet 24 is discharged into the enclosure 18.

The material in the enclosure 18 is combusted or gasified by the heat in the furnace section 12 and the mixture of air and gaseous products of combustion (hereinafter referred to as "flue gases") passes upwardly through the enclosure 18 and entrain, or elutriate, the relatively fine particulate material in the enclosure. The velocity of the air introduced, via the air plenum 20, through the air distributor 22 and into the interior of the enclosure 18 is established in accordance with the size of the particulate material in the enclosure 18 so that a circulating fluidized bed is formed, i.e. the particulate material is fluidized to an extent that substantial entrainment or elutriation of the particulate material in the bed is achieved. Thus the flue gases passing into the upper portion of the enclosure 18 are substantially saturated with the particulate material.

The saturated flue gases pass to the upper portion of the enclosure 18 and exit through the outlet 18a and then pass through ducting (not shown) to the inlet 60 of the separator 14 as shown by the dashed lines in Figure 1. The inlet 60 is arranged so that the flue gases containing the particulate material enter in a direction substantially tangential to the chamber 64 and thus swirl around in the chamber. The entrained solid particles are thus propelled, by centrifugal forces, against the inner wall of the cylindrical section 44 where they collect and fall downwardly by gravity into the hopper section 42.

The relatively clean gases remaining in the chamber 64 are prevented from flowing upwardly by the roof section 40, and thus enter the pipe 62 through its lower end. The gases pass through the length of the pipe 62 before exiting from the upper end of the pipe. The gases then pass through ducting (not shown) to the inlet 70a of the heat recovery section 16 and then pass downwardly through the length of the enclosure 70 and across the superheaters 80a, 805, 82a and 82b and the economizers 84a and 84b before exiting, via the outlet 70b, to external equipment.

The fluid accumulating in the steam drum 32 separates into liquid and steam with the relative hot fluid, or steam, rising to the upper portion of the drum by natural convection and the relatively cool fluid, or liquid, falling to the lower portion of the drum. The steam from the upper portion of the drum 32 is passed, via the downcomer 38 and branch pipes into the section 48a of the lower ring header 48 of the separator 14, and passes, by convection, upwardly through the tubes 52 in parallel on to left side of the separator. Since the steam is at a temperature less than the temperature of the separator 14 and, more Particularly, the flue gases in the separator, the temperature of the separator is reduced. The steam is collected in the section 50a of the upper header 50 and passes via the conduit 74[1] to the section 50b of 50, then the steam passes downwardly through tubes 52 forming the right ends of the separator to the section 48b of the lower ring header. Thereafter the steam passes via the riser pipe 75 to the headers 76 of the heat recovery section. The steam passes downwardly through the length of the walls forming the enclosure 70 to lower headers (not shown) which are connected to the flow circuitry including the steam drum 32.

Thus the steam passes downwardly to the lower portion of the separator 14, upwardly through a portion of the separator, then downwardly through another portion of the separator, then upwardly to the heat recovery section, and then downwardly through the latter section.

The separated particulate material in the separator passes through the hopper section 42, the pipe 66 and the seal pot 68 before it is injected, via the pipe 69, back into the circulating fluidized bed in the enclosure 18.

Several advantages result from the system of the present invention. For example, the temperature of the separator 14 is reduced considerably due to the relatively cool fluid passing through its walls. Thus, heat losses from the separator 14 are reduced and the requirement for internal refractory insulation is minimized. Also, the bulk, weight, and cost of the separator 14 is much less than that of conventional separators, and start-up and load changes can be completed relatively quickly. Further, the need for expensive high temperature refractory-lined ductwork and expansion joints between the reactor and cyclone separator, and between the latter and the heat recovery section is minimized. Still further, superheating of the fluid is improved as well as the ability to control the temperature range thereof.

The inner pipe 62 of the separator 14 can be formed of tubes in a manner similar to the separator 14 and the latter tubes can be connected to the flow circuit including the steam drum 32.

Claims

1. A fluidised bed steam generating system (10) comprising:
   (A) a furnace (12) comprising:
      (1) an enclosure (18) containing solid particulate material including fuel; and
      (2) means (20) for introducing air into the enclosure (18) at a velocity sufficient to fluidise the particulate material and support combustion or gasification of the fuel to produce flue gases which rise in the en-

closure (18) and entrain a portion of the particulate material;

(B) a cyclone separator (14) comprising:

(1) an inner cylinder (62); and

(2) an outer housing surrounding the inner cylinder (62) for forming a separating chamber (64), the outer housing comprising:

(a) a plurality of parallel tubes (52); and

(b) means (54) connecting the tubes to form an air tight structure;

(C) a heat recovery section (16) comprising:

(1) an enclosure (70) comprising:

(a) a plurality of parallel tubes; and

(b) means connecting the tubes to form an air tight structure;

(2) a plurality of bundles of tubes (82a, 82b,80a,80b,84a,84b) disposed in the enclosure;

(D) means for passing the flue gasses from the furnace section (12) to the chamber (64) for separating the entrained particulate material from the flue gases by centrifugal forces;

(E) means (66) for passing the separated particulate material from the separator (14) back to the furnace section (12); and

(F) means for passing the separated flue gases to the heat recovery section (16);

characterised by

(G) fluid flow circuit means comprising:

(1) a steam drum (32);

(2) a lower ring header (48) formed in two sections (48a,48b) respectively connected to portions of the tubes (52) forming the outer housing of the separator (14), and an upper ring header (50) formed into two sections (50a,50b) respectively connected to the said portions of the tubes (52) forming the outer housing of the separator (14);

(3) means (38) for connecting the steam drum (32) to a section (48a) of the lower ring header (48) and in turn one portion of the tubes (52) for passing steam upwardly through that portion of the tubes (52) and to one section (50a) of the upper ring header (50) to cool the separator (14); and

(4) means (75) for connecting the tubes (52) forming the outer housing to the tubes of the heat recovery section (16) so that fluid passing through the latter tubes is heated by the separated flue gases.

2. A steam generating system as claimed in Claim 1 in which the cyclone separator (14) comprises a cylindrical section (44), and a hopper section (42) and a roof section (40) respectively connected to the ends of the cylindrical section and formed by the tubes (52).

3. A steam generating system as claimed in Claim 1 or Claim 2 in which the tubes (52) forming the outer cylinder of the cyclone separator (14) are spaced and the outer cylinder further comprises a plurality of continuous fins (54) extending for the length of the tubes (52) and connected thereto to form an air tight structure.

4. A steam generating system as claimed in any preceding claim further comprising additional conduit means (74') for connecting the said one section (50a) of the second ring header to the other section (50b) thereof for passing the steam downwardly through the remaining portion of the tubes (52) to the other section (38b) of the first ring header.

5. A steam generating system as claimed in Claim 4 in which the means (75) for connecting the tubes (52) of the outer housing of the separator (14) to the tubes of the heat recovery section (16) comprises conduit means (75) connecting the said other section (38b) of the second ring header to the tubes of the heat recovery section (16).

Patentansprüche

1. Eine Wirbelschichtdampferzeugungsanlage (10), umfassend:

(A) eine Brennkammer (12) mit:

(1) einer festes teilchenförmiges Material einschließlich Brennstoff enthaltenden Umkleidung (18); und

(2) Mitteln (20) zur Einführung von Luft in die Umkleidung (18), und zwar mit einer Geschwindigkeit, die ausreichend ist, um das teilchenförmige Material zu fluidisieren und die Verbrennung bzw. Vergasung des Brennstoffs in Gang zu halten, so daß Rauchgase erzeugt werden, die innerhalb der Umkleidung (18) aufsteigen und einen Teil des teilchenförmigen Materials mitführen;

(B) einen Zyklonabscheider (14) mit:

(1) einem Innenzylinder (62); und

(2) einem den Innenzylinder (62) zwecks Bildung einer Abscheidekammer (64) umgebenden Außengehäuse, wobei das Außengehäuse

(a) eine Vielzahl von parallelen Rohren (52); und

(b) Mittel (54), die die Rohre so miteinander verbinden, daß eine luftdichte Struktur entsteht, umfaßt;

(C) eine Wärmerückgewinnungsstufe (16)

mit:

(1) einer Umkleidung (70), umfassend:

(a) eine Vielzahl von parallelen Rohren; und

(b) Mittel, die die Rohre so miteinander verbinden, daß eine luftdichte Struktur entsteht;

(2) einer Vielzahl von Rohrbündeln (82a, 82b, 80a, 80b, 84a, 84b), die innerhalb der Umkleidung angeordnet sind;

(D) Mittel zum Leiten der Rauchgase von der Brennkammerstufe (12) zu der Kammer (64) zwecks Abscheidung durch Zentrifugalkräfte des mitgeführten teilchenförmigen Materials von den Rauchgasen;

(E) Mittel (66) zum Zurückleiten des abgeschiedenen teilchenförmigen Materials von dem Abscheider (14) zu der Brennkammerstufe (12); und

(F) Mittel zum Leiten der abgeschiedenen Rauchgase zu der Wärmerückgewinnungsstufe (16);

gekennzeichnet durch

(G) Flüssigkeitsstromkreismittel, umfassend

(1) eine Dampftrommel (32);

(2) einen aus zwei Teilen (48a, 48b) bestehenden unteren Ringsammler (48), wobei die beiden Teile jeweils an Teile der das Außengehäuse des Abscheiders (14) bildenden Rohre (52) angeschlossen sind, sowie einen aus zwei Teilen (50a, 50b) bestehenden oberen Ringsammler (50), wobei die beiden Teile jeweils an die besagten Teile der das Außengehäuse des Abscheiders (14) bildenden Rohre (52) angeschlossen sind;

(3) Mittel (38) zum Anschließen der Dampftrommel (32) an einen Teil (48a) des unteren Ringsammlers (48) und weiterhin an einen Teil der Rohre (52), um durch den besagten Teil der Rohre (52) Dampf aufwärts zu leiten, sowie an einen Teil (50a) des oberen Ringsammlers (50), um den Abscheider (14) zu kühlen; und

(4) Mittel (75) zum Verbinden der das Außengehäuse bildenden Rohre (52) mit den Rohren der Rückgewinnungsstufe (16), so daß

durch die letzteren Rohre strömendes Fluid durch die abgeschiedenen Rauchgase erwärmt wird.

2. Eine Dampferzeugungsanlage nach Anspruch 1, bei der der Zyklonabscheider (14) einen zylindrischen Teil (44), einen Trichterteil (42) und einen Dachteil (40) umfaßt, die jeweils an die Enden des zylindrischen Teils angeschlossen und durch die Rohre (52) gebildet sind.

3. Eine Dampferzeugungsanlage nach Anspruch 1 oder Anspruch 2, bei der die den Außenzylinder des Zyklonabscheiders (14) bildenden Rohre (52) in Abstand voneinander angeordnet sind und der Außenzylinder des weiteren eine Vielzahl kontinuierlicher Streifen (54) umfaßt, die sich über die Länge der Rohre (52) erstrecken und mit diesen so verbunden sind, daß eine luftdichte Struktur entsteht.

4. Eine Dampferzeugungsanlage nach einem der vorstehenden Ansprüche, die des weiteren zusätzliche Leitungsmittel (74') zum Anschließen des besagten einen Teils (50a) des zweiten Ringsammlers an den anderen Teil (50b) des besagten Ringsammlers umfaßt, um den Dampf durch den restlichen Teil der Rohre (52) abwärts zu dem anderen Teil (38b) des ersten Ringsammlers zu leiten.

5. Eine Dampferzeugungsanlage nach Anspruch 4, bei der das Mittel (75) zum Anschließen der Rohre (52) des Außengehäuses des Abscheiders (14) an die Rohre der Wärmerückgewinnungsstufe (16) ein Rohrleitungsmittel (75) zum Anschließen des besagten anderen Teils (38b) des zweiten Ringsammlers an die Rohre der Wärmerückgewinnungsstufe (16) umfaßt.

Revendications

1. Système générateur de vapeur à lit fluidisé (10) comprenant:

(A) un four (12) comprenant:

(1) une enceinte (18) contenant du combustible comprenant des matériaux particulaires solides; et

(2) un moyen (20) pour introduire de l'air dans l'enceinte (18) à une vitesse suffisante pour fluidiser le matériau particulaire et entretenir la combustion ou la gazéification du combustible pour produire des gaz de carneau qui montent dans l'enceinte (18) et entraînent une partie du matériau particulaire;

(B) un séparateur à cyclone (14) comprenant:

(1) un cylindre intérieur (62); et

(2) un logement extérieur entourant le cylindre intérieur (62) pour former une chambre de séparation (64), le logement extérieur comprenant:

(a) une pluralité de tubes parallèles (52); et

(b) un moyen (54) reliant les tubes pour former une structure étanche à l'air;

(C) une section de récupération de chaleur (16) comprenant:

(1) une enceinte (70) comprenant:
(a) une pluralité de tubes parallèles; et
(b) un moyen reliant les tubes pour former une structure étanche à l'air;
(2) une pluralité de faisceaux de tubes (82a, 82b, 80a, 80b, 84a, 84b) disposés dans l'enceinte;
(D) un moyen pour faire passer les gaz de carneau de la section four (12) à la chambre (64) pour séparer par des forces centrifuges le matériau particulaire entraîné des gaz de carneau;
(E) un moyen (66) pour faire repasser le matériau particulaire séparé du séparateur (14) à la section four (12); et
(F) un moyen pour faire passer les gaz de carneau séparés à la section récupération de chaleur (16);
caractérisé par
(G) un moyen de circuit d'écoulement fluide comprenant:
(1) un collecteur de vapeur (32);
(2) un distributeur annulaire inférieur (48) formé de deux sections (48a, 48b) reliées respectivement à des parties des tubes (52) formant le logement extérieur du séparateur (14) et un distributeur annulaire supérieur (50) formé de deux sections (50a, 50b) reliées respectivement auxdites parties des tubes (52) formant le logement extérieur du séparateur (14);
(3) un moyen (38) pour relier le collecteur de vapeur (32) à une section (48a) du distributeur annulaire inférieur (48) et ainsi à une partie des tubes (52) pour faire passer la vapeur vers le haut par cette partie des tubes (52) et à une section (50a) du distributeur annulaire supérieur (50) pour refroidir le séparateur (14); et
(4) un moyen (75) pour relier les tubes (52) formant le logement extérieur aux tubes de la section récupération de chaleur (16) de telle sorte que le fluide passant par ces derniers tubes soit chauffé par les gaz de carneau séparés.

2. Système générateur de vapeur selon Revendication 1 dans lequel le séparateur à cyclone (14) comprend une section cylindrique (44), et une section trémie (42) et une section toit (40) respectivement reliées aux extrémités de la section cylindrique et formées par les tubes (52).

3. Système générateur de vapeur selon Revendication 1 ou Revendication 2 dans lequel les tubes (52) formant le cylindre extérieur du séparateur à cyclone (14) sont espacés et le cylindre extérieur comprend en outre une pluralité d'ailettes continues (54) se prolongeant sur la longueur des tubes (52) et reliées à ceux-ci pour former une structure étanche à l'air.

4. Système générateur de vapeur selon l'une quelconque des revendications précédentes comprenant en outre un moyen de conduit supplémentaire (74') pour relier ladite section (50a) du deuxième distributeur annulaire à son autre section (50b) pour faire passer la vapeur vers le bas par la partie restante des tubes (52) à l'autre section (38b) du premier distributeur annulaire.

5. Système générateur de vapeur selon Revendication 4 dans lequel le moyen (75) pour relier les tubes (52) du logement extérieur du séparateur (14) aux tubes de la section récupération de chaleur (16) comprend un moyen de conduit (75) reliant ladite autre section (38b) du deuxième distributeur annulaire aux tubes de la section récupération de chaleur (16).

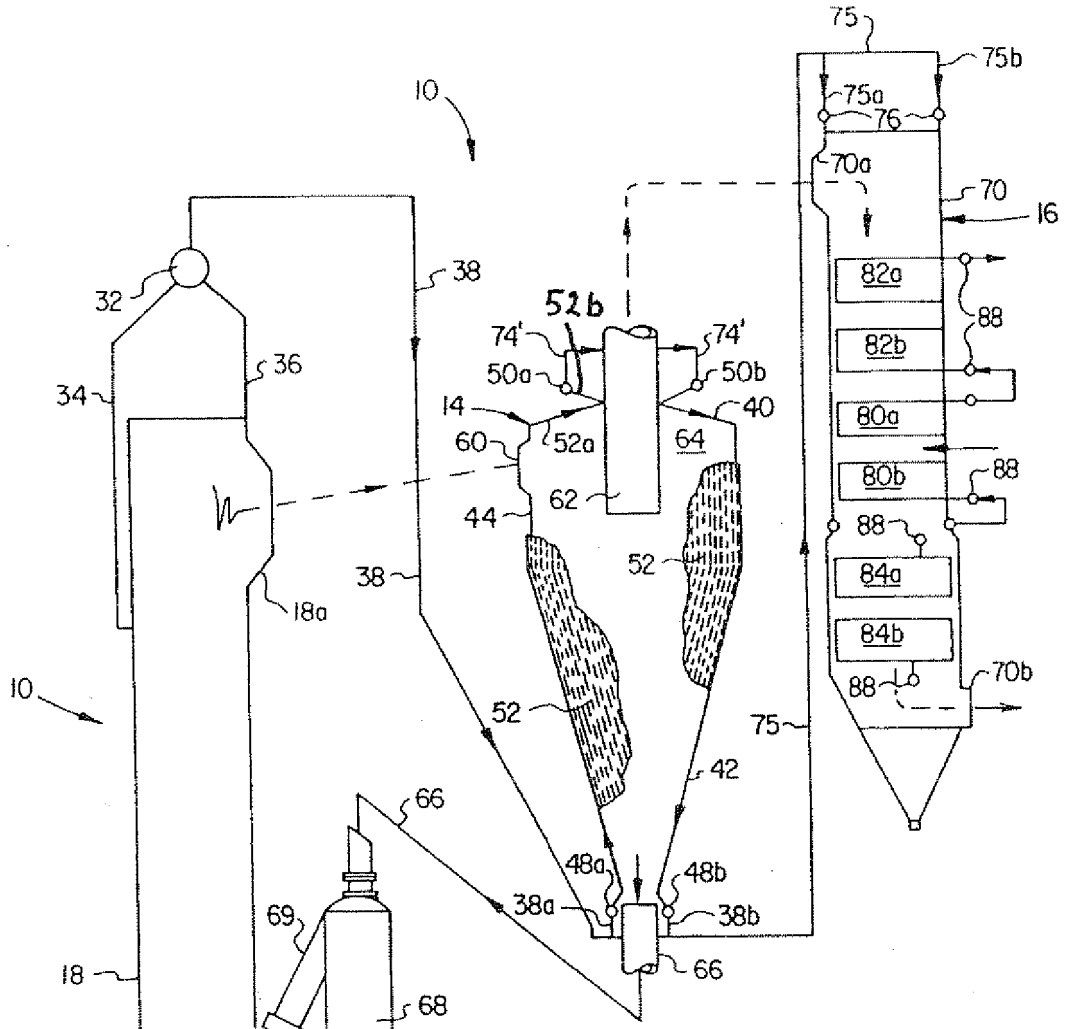
10
75
75b
75a
76
70a
70
16
82a
82b
80a
80b
84a
84b
88
70b
32
34
36
38
52b
74'
50a
50b
14
52a
60
62
64
40
44
52
18a
66
69
68
18
12
24
22
20
48a
48b
38a
38b
42

FIG. 1

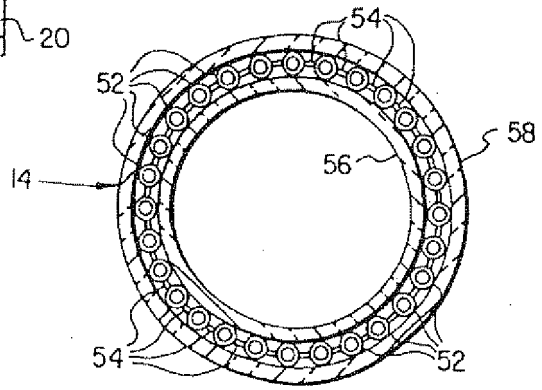
54
52
58
56
14
54
52

FIG. 2